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(Theory, Practice and Solved Problems)

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Dedicated to

Saroj, Sheetal and Chetan

FOREWORD

There has been a long-felt need of a book giving comprehensive and systematic information of "Switchgear and Protection and Power System Studies". The author is to be congratulated for fulfilling this need by publishing a book. I am proud that Shri Sunil S.Rao, the author of the book, is an old student of mine and I am very happy to write this foreword.

The author has a brilliant academic career and holds a first-class B.E. degree in Electrical Engineering of Karnataka University and a first class M.E. degree in 'Power Systems' of Poona University. He has good practical experience in many of the reputed Electrical Firms and Organisations like Hindustan Brown Boveri Ltd., Baroda, Kirlosker Electrical Co Ltd, Bangalore, State Electricity Boards of Karnataka and Maharashtra etc. He is working at Maulana Azad Regional College of Technology, Bhopal, as a lecturer in Electrical Engineering, and has been teaching "Switchgear Protection and Power Systems".

The author has presented the subject matter in five sections, spread over 59 chapters. **Section I** deals with principles of current interruption, constructional and operational aspects of various circuit breakers including SF₆ circuit breakers, vacuum circuit breakers, and discusses about the choice, erection, maintenance and testing of high voltage/low voltage switchgear and EHV apparatus. EHV A.C. Transmission and HVDC transmission.

Section II deals with fault current calculations, role of network analysers and digital computers in the calculation of fault current of complicated system networks.

Section III deals with constructional and operational aspects of electromagnetic protective relays and protective systems for generators, transformers, motors and transmission lines.

Section IV deals with fundamentals of static relays and static protection schemes.

Section V deals with advanced topics in power system controls, applications of digital computer and microprocessors for load-frequency control and back-up protection, Power-System Stability, Load Frequency Control, Voltage control and compensation of Reactive Power, Voltage Stability, Power System Network Automation have been explained.

The matter is presented in a very lucid style and simple English. The book is profusely illustrated by neat, clear sketches and diagrams and graphs. The author is to be congratulated for having consulted the leading technical journals in the field and presenting the information regarding "Switchgear Protection and Power Systems" up-to-date, in his book. The author has exhibited a mature art of teaching in the presentation of the subject matter inspite of his short teaching experience. Some typical solved problems are given throughout the book.

With addition of some unsolved problems, summary and provocative questions at the end of each chapter, the book may serve as a text book in universities for a course in "Switchgear Protection and Power Systems" in the under-graduate and postgraduate curriculum. The book should also serve as a useful guide and reference to Power Engineers, considering the volume of practical information it provides.

I am very proud of the young author and express my sincere thanks to him for giving me the privilege of writing the Foreword to this book of his.

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PREFACE TO THE THIRTEENTH EDITION

The widespread acceptance of the earlier Editions promoted this revised and enlarged edition. The book presents in-depth knowledge about the principles and practices of modern power system engineering. It gives an integrated approach to the complex phenomena related with Switchgear, Protection, Fault-Calculations, Power System Analysis-Operation-Control-Automation, Digital relays, Micro-processor based Relays and Microprocessor based Integrated Control and Protection Systems, Energy Systems.

The book will serve as a regular text book for electrical engineering courses to prepare the students for the careers in power sector. The book will also serve as a reference book to electrical engineers working in power sector, electrical manufacturing industry, academic and testing institutions, etc.

Since the publication of the first edition of the book Switchgear and Protection in 1973, many advances have occurred in field of the Switchgear, Protection and Power System Automation. While the conventional protection and switching devices will continue to serve, entirely new type of devices and techniques are now available. The development of SF₆ and Vacuum circuit-breakers have made the other types nearly obsolete. The static relays have replaced the electro-mechanical relays. EHV-A.C and HVDC transmission are now commercially successful. Large interconnected networks are being automatically controlled from load control centres by means of on-line SCADA, AGC and EMS Systems. The developments in power electronics have resulted in the successful use of static VAR Sources (SVS), HVDC Convertors etc. Digital computers and microprocessors are being increasingly used for protection and automation. Fibre-optic cables have been successfully used for data transmission.

Due to the energy crisis and increasing capital costs of power projects, there is a world-wide trend towards interconnecting adjacent AC Networks by means of EHV-A.C or HVDC links.

The techniques of testing and maintenance have advanced with an aim of increased reliability and availability of electrical power supply. Knowledge of specifications, testing, maintenance, commissioning has gained significance. The power system analysis techniques have also advanced significantly.

India and other developing countries have ambitious development plans in power sector. Some landmarks in the power sector of India include indigenous capability of design, manufacture and commissioning of EHV-A.C Sub-stations and apparatus, establishment of 400 kV. AC network, introduction of HVDC Systems, interconnections between Regional Grids, introduction of static relays and static protection systems, increasing use of digital computers and microprocessors, expansion of testing facilities, etc.

The technology of protection and automation have been revolutionised by the introduction of microprocessor based combined protection, control, monitoring systems. Such systems have been introduced for substation protection, generator protection, HVDC protection. This book covers the principles and applications of this latest technology and the important topics in Interconnected Power Systems. The new chapters include EHV-A.C Transmission, HVDC Transmission Systems, Interconnections, Power System Automation with SCADA Systems, Power System Planning, Latest Power map of India, Microprocessor based Protection. Energy Technology-Renewable and Nonconventional and Conventional. The Correlation between Energy Sector and Power sector has been illustrated.

Chapters on Power system Calculations and Load Flow Studies, The principles and procedures of network calculations and load flow studies have been simplified and explained by a few solved examples. 'Recent Advances' in Intelligent Circuit Breakers, Fiber-optic Cable Applications, Compact Intelligent Substations, ISO-9000 and TQM are covered in Appendix-A, while Appendix-B highlights overall system description of Distribution Management System.

The patronage of Academic Institutions and Power System Engineers to this book is hereby gratefully acknowledged.

— Author

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CONTENTS

SECTION I — SWITCHGEAR AND SUB-STATION APPARATUS

1. INTRODUCTION	1-15
1.1. Switchgear and Protection	1
1.2. Sub-station Equipment	3
1.3. Faults and Abnormal Conditions	4
1.4. Fault Calculations	4
1.5. Fault Clearing Process	5
1.6. Protective Relying	5
1.7. Neutral Grounding (Earthing) and Equipment Grounding	5
1.8. Over-voltages and Insulation Co-ordination	6
1.9. Some Terms in the Test	6
1.10. Standard Specifications	7
1.11. Electro-mechanical Relays and Static Relays	8
1.12. Applications of On-line Digital Computers Microprocessors And Static Protective/control Devices in Power System	8
1.13. Interconnected Power System	9
1.14. Load-frequency Control, Load Shedding	10
1.15. Voltage Levels in Network and Sub-stations	11
1.16. Voltage Control of AC Network	11
1.17. Static Var Sources (SVS)	13
1.18. Power System Stability	13
1.19. HVDC Option	14
1.20. Power System Analysis	14
1.21. Power System Network Calculations and Load Flow	15
1.22. Objective and Tasks	15
2. HIGH-VOLTAGE A.C. CIRCUIT-BREAKERS	16-31
2.1. Introduction	16
2.2. The Fault Clearing Process	16
2.3. The Trip-circuit	17
2.4. Recent Advances	17
2.5. Classification Based on Arc Quenching Medium	18
2.6. Technical Particulars of a Circuit-breaker	19
2.7. Assembly of Outdoor Circuit-breakers	20
2.8. Structural Form of Circuit-breakers	22
2.9. Operating Mechanisms	22
2.9.1. Closing Operation	23
2.9.2. Opening Operation	24
2.9.3. Closing Followed by Opening Operating	24
2.9.4. Types of Mechanisms	24
2.10. Interlocks, Indication and Auxiliary Switch.	26
2.11. Circuit-breaker Time (Total Break Time)	27
2.12. Auto Reclosure	27
2.13. Auto Reclosure of EHV Circuit Breakers for Transmission Lines	28
2.14. Auto Reclosure for Distribution Lines (Upto 33 kv)	29
2.15. Weight Operated Reclosing, Pole Mounted Circuit-breakers	29

(x)	(xi)	71
2.16. Trip-free Feature	30	
2.17. Materials	30	
2.18. Design and Development	30	
3. FUNDAMENTALS OF FAULT CLEARING, SWITCHING PHENOMENA AND CIRCUIT-BREAKER RATING	32-73	
3.1. Introduction	32	
3.2. Network Parameters : R, L, C	32	
3.3. Voltage Equation of an RLC Series Circuit	34	
3.4. Sudden Short Circuit of R.L. Series Circuit	38	
3.5. Sub-transient, Transient and Steady State	41	
3.6. Current Interruption in A.C. Circuit-breakers	42	
3.7. Transient Recovery Voltage (TRV)	44	
3.7.1. Effect of Natural Frequency of TRV	44	
3.7.2. Effect of Power-factor on TRV	45	
3.7.3. Effect of Reactance-drop on Power-frequency Recovery Voltage	45	
3.7.4. Effect of Armature Reaction on Recovery Voltage	45	
3.7.5. Effect of the First-pole-to-clear	45	
3.7.6. The First-pole-to-clear Factor	45	
3.8. Single Frequency Transient	46	
3.9. Double Frequency Transients	47	
3.10. Rate of Rise of TRV	48	
3.11. Resistance Switching, Damping of TRV, Opening Resistors	53	
3.12. Interruption of Low Magnetizing Current, Current Chopping	53	
3.13. Use of Opening Resistors	55	
3.13.1. Switching of Capacitor Banks	55	
3.13.2. Switching of Unloaded Transmission Lines and Unloaded Cables	57	
3.14. Interrupting the Terminal Faults	58	
3.15. Interrupting Short Line Faults (Kilometric Fault)	58	
3.16. Phase Opposition Switching	59	
3.17. Specifying the TRV Wave	60	
3.18. Rated Characteristics of Circuit-breakers	61	
3.18.1. Rated Voltage	61	
3.18.2. Rated Insulation Level	61	
3.18.3. Rated Frequency	61	
3.18.4. Rated Normal Current (Rated Current)	62	
3.18.5. Rated Short Circuit-breaking Current	63	
3.18.6. Rated Short-circuit Making Current	63	
3.18.7. Rated Duration of Short-circuit (Rated Short Time Current)	64	
3.18.8. Rated Operating Sequence (Duty Cycle)	65	
3.18.9. Rated Transient Recovery Voltage for Terminal Faults	65	
3.18.10. Representation of a TRV Waveform by Four Parameter Method	66	
3.18.11. Representation of TRV Waveform by Two-parameter Method	66	
3.18.12. Rated Peak Withstand Current	67	
3.18.13. Rated Quantities for Auxiliary Circuits and Operating Mechanisms For Opening and Closing	68	
3.18.14. Rated Pressure of Supply for Pneumatic and Hydraulic Operating Devices	69	
3.18.15. Rated Pressure of Interrupting Medium and Insulating Medium	69	
3.18.16. Summary of Rated Characteristics of HV (A.C.) Circuit-breakers	69	
3.18.17. Rated Out-of-phase Breaking Current	70	
3.18.18. Rated Cable-charging Breaking Current	71	
3.18.19. Rated Single Capacitor Bank Breaking Current		71
3.18.20. Permissible Maximum Switching Over-voltages When Interrupting Line-Charging, Cable-charging and Single Capacitor Bank Breaking Current		71
3.18.21. Rated Capacitor Bank Inrush Making Current		71
3.18.22. Rated Small Inductive Breaking Current		71
3.19. Reignition and Restrike		72
4. THE ARC-EXTINCTION	74-82	
4.1. Introduction		74
4.2. The Matter and Plasma		74
4.3. Ionization of Gases		75
4.4. Deionization		76
4.5. Electric Arc		76
4.6. Arc Formation in A.C. Circuit-breakers		77
4.7. Modes At Arc Extinction		78
4.7.1. High Resistance Interruption, Blow-out Coils		78
4.7.2. Low Resistance of Zero Point Extinction		79
4.8. Arc Interruption Theories		80
4.9. Arc Extinction in Oil		81
4.10. Arc Extinction in Vacuum		82
4.11. Arc Extinction in Air-blast		82
4.12. Arc Extinction in SF ₆ Gas		82
4.13. Arc Time Constant		82
5. AIR-BREAK CIRCUIT-BREAKER	83-88	
5.1. Introduction		83
5.2. Construction of Air-break Circuit-breaker		83
5.3. Arc Extinction in A.C. Air-break C.B.		84
5.4. Lengthening of Arc by Means of Magnetic Fields		85
5.5. Description of a Low Voltage Air-breaker Circuit-breaker		85
5.6. Operating Mechanisms for Air-break Circuit-breakers		87
5.7. Series Connected Over Load Trip Coil Arrangement		87
5.8. Air-break D.C. Circuit-breakers for Medium Voltages		87
5.9. Miniature Circuit-breaker, Moulded Case Circuit-breakers		88
6. AIR BLAST CIRCUIT-BREAKER	89-96	
6.1. Introduction		89
6.2. Construction of an Air Blast Circuit-breaker		89
6.3. Principle of Arc Quenching in Abcb		91
6.4. Circuit-breakers with External Extinguishing Energy		92
6.5. Resistance Switching in Abcb		93
6.6. Voltage Distribution in Multi-break Circuit-breakers (abcb-moch, SF ₆)		94
6.7. Reducing Switching Over-voltages by Pre-closing Resistor		95
6.8. Generator Circuit Breakers		95
6.9. Compressed Air System for ABCB		96

7. SULPHUR HEXAFLUORIDE (SF₆) CIRCUIT-BREAKER AND SF₆ INSULATED METALCLAD SWITCHGEAR (GIS)	97-121
Part I : Properties of SF₆ Gas	
7.1. Introduction	97
7.2. Physical Properties of SF ₆ Gas	97
7.3. Chemical Properties of SF ₆ Gas	98
7.4. Dielectric Properties of SF ₆ Gas	99
7.5. Arc Extinction in SF ₆ Circuit-breakers	100
7.5.1. Single Pressure Puffer Type Circuit-breaker with Single Flow of Quenching Medium	101
7.5.2. Double Flow of Quenching Medium	103
Part II : Outdoor SF₆ Circuit Breakers	
7.6. Types Design	103
7.7. Single Pressure Puffer Type SF ₆ Circuit-breaker	104
7.7.1. Configuration of a Single Pressure Puffer Type EHV Circuit-breaker	105
7.8. Double Pressure Dead Tank SF ₆ C.B. (Now Obsolete)	106
7.9. Merits of SF ₆ Circuit-breakers	107
7.10. Some Demerits of SF ₆ Circuit-breaker	107
7.11. SF ₆ Filled Load Break Switches	107
7.12. Gas Monitoring and Gas Handling Systems	108
Part III : SF₆ Insulated Metalclad Switchgear (Sub-Station)	
7.13. Introduction to SF ₆ Switchgear (GIS)	108
7.14. Advantages of SF ₆ Switchgear	109
7.15. Demerits of SF ₆ Insulated Switchgear	109
7.16. General Constructional Features of SF ₆ -Gas Insulated Switchgear (GIS)	109
7.17. Gas Monitoring	109
7.18. Gas Filling and Monitoring System for SF ₆ Switchgear	114
7.19. Transportation and Handling of SF ₆ Gas	118
7.20. Gas Transfer Units	118
7.21. SF ₆ Insulated EHV Transmission Cables (GIC)	118
7-A. Routine, Site/Field Testing of GIS	122-130
7.22. Routine Testing of GIS	122
7.23. Site/field Testing of GIS	128
8. MINIMUM OIL CIRCUIT-BREAKER AND BULK OIL CIRCUIT-BREAKER	131-137
8.1. Introduction	131
8.2. Tank Type Bulk Oil Circuit-breaker (Now Obsolete)	131
8.3. Minimum Oil Circuit-breaker	133
8.4. Principle of Arc-extinction on Oil Breakers	134
8.5. Pre-arcning Phenomenon	135
8.6. Sensitivity to TRV	135
8.7. Circuit-breakers with Internal Sources of Extinguishing Energy—Critical Current	136
8.8. Contact Assembly	136

9. VACUUM INTERRUPTER AND VACUUM CIRCUIT-BREAKER	138-153
9.1. Introduction	138
9.2. Electrical Breakdown in High Vacuum	139
9.3. Arc Extinction in Vacuum Interrupters	140
9.4. Construction of a Vacuum Interrupter	140
9.5. Arc Interruption in High Vacuum	142
9.6. Degree of Vacuum in Interrupters	142
9.6.1. Construction of a Vacuum Interrupter	142
9.7. Interruption of Short-circuit Currents in Vacuum Interrupters	143
9.8. Design Aspects of Vacuum Interrupters	144
9.8.1. Length of Interrupter	144
9.8.2. Contact Travel (Contact (GAP))	144
9.8.3. Contact Shape	144
9.8.4. Contact Size and Shape for Required Short-circuit Breaking Current	145
9.8.5. Contact Material	147
9.9. Time/travel Characteristics	147
9.10. Contact Pressure	147
9.11. Contact Acceleration During Opening	148
9.12. Contact Erosion	148
9.13. Vacuum Level and Shelf Life of Interrupters	149
9.14. Checking of Vacuum	149
9.15. Range of Vacuum Switchgear, Vacuum Controlgear and Vacuum Circuit-breakers	149
9.16. Merits of VCB's	151
9.17. Demerits of VCB's	151
9.18. Switching Phenomena with VCB	151
9.18.1. Reignition in Vacuum Circuit-breakers	151
9.18.2. Capabilities of Modern Circuit Breakers for Medium Voltages	152
9.18.3. Switching Over-voltage Problem with Vcb for Motor Switching Duty, RC Surge Suppressors	152
10. TESTING OF HIGH VOLTAGE A.C. CIRCUIT-BREAKER	154-163
10.1. Classification of the Test	154
10.2. Type Tests	155
10.2.1. Mechanical Test (Endurance Tests)	156
10.2.2. Temperature-rise Tests	156
10.2.3. Measurement of D.C. Resistance	157
10.2.4. Millivolt Drop Tests	157
10.2.5. No-load Operation Tests and Oscillographic and Other Records	157
10.2.6. Dielectric Tests	158
10.2.7. Basic Short-circuit Test Duties	158
10.3. Routine Tests	159
10.4. Development Tests	159
10.5. Reliability Tests	159
10.6. Commissioning Tests	160
10.7. Insulation Resistance Measurement at Site	161
10.8. High Voltage Power Frequency Withstand Test (Routine Test)	162
10.9. Routine Tests on Circuit-breakers	162
10.9.1. Mechanical Operating Tests (Routine Test)	162

11. SHORT CIRCUIT TESTING OF CIRCUIT-BREAKERS	164-189
11.1. Introduction	164
11.2. Stresses on Circuit-breaker During Short-circuit Tests	164
Part A : Short-Circuit Test Plants	
11.3. Short-circuit Testing Plants	165
Part B : Direct Testing	
11.4. Direct Testing	169
11.5. Rules for Type Tests	170
11.6. Short-time Current Tests on Circuit-breakers, Isolators, Busbars, CTS Etc.	170
11.7. Basic Short-circuit Test Duties	173
11.8. Critical Current Tests	174
11.9. Short-line Fault Tests	174
11.10. Line Charging Breaking Current Tests	175
11.11. Out-of-phase Switching Tests	176
11.12. Capacitive Current Switching Tests	176
11.12.1. Single Capacitor Bank Current Breaking Test	178
11.13. Cable-charging Breaking Current Test	179
11.13.1. Small Inductive Current Breaking Tests	179
11.13.2. Recommendations for Small Inductive Current Switching Tests	180
11.14. Reactor Switching Test	181
Part C : Indirect Testing	
11.15. Unit Testing or Element Testing	183
11.16. Synthetic Testing	183
11.17. Substitution Test	186
11.18. Capacitance Test	187
11.19. Compensation Test	188
11.20. Development Testing of Circuit-breakers	188
12. INSULATION REQUIREMENT AND HIGH VOLTAGE TESTING OF CIRCUIT BREAKERS	190-199
12.1. Introduction	190
12.2. Overvoltages	191
12.3. Design Aspects	191
12.4. Causes of Failure of Insulation	191
12.5. Purpose of H.V. Testing of Circuit-breakers	192
12.6. Tests on a High Voltage Circuit-breakers	193
12.7. Some Terms and Definitions.	194
12.8. Impulse Voltage Tests and Standards Impulse Waves	195
12.9. Impulse Generator	195
12.10. Test Plant for Power Frequency Tests	196
12.11. H.V. Testing Transformer	196
12.12. Sphere Gaps	197
13. INSTALLATION AND MAINTENANCE	200-217
13.1. Introduction	200
13.2. Break Down Maintenance Versus Preventive Maintenance	200
13.3. Inspection, Servicing, Overhaul	201
13.4. Guidelines for Maintenance of Switchgear	201
13.5. Field Quality Plans (FQP)	202

13.6. Maintenance of Circuit Breakers	203
13.7. Typical Maintenance Record Card	207
13.8. Maintenance of Air Break Circuit Breaker, Fusegear for Low And Medium Voltages	207
13.9. Maintenance of Vacuum Circuit-breaker	208
13.10. Maintenance of SF ₆ Circuit-breaker	208
13.11. Insulation Resistance Measurement	210
13.12. Insulation Resistance Measurement at Site	210
13.13. Likely Troubles and Essential Periodic Checks	211
13.14. Installation of Drawout Metalclad Switchgear	212
13.15. Safety Procedures	214
13.16. Installation of Outdoor Circuit-breakers	216
14. HRC FUSES AND THEIR APPLICATIONS	218-232
14.1. Introduction	218
14.2. Types of Devices with Fuse	218
14.3. Definitions	218
14.4. Construction	219
14.4.1. HRC Fuses for Semiconductor Devices and Thyristors	220
14.5. Fuse Link of HRC Fuse	222
14.6. Action of HRC Fuse	222
14.7. Shape of Fuse Element	222
14.8. Specification of a Fuse Link	223
14.9. Characteristic of a Fuse	224
14.10. Cut-off	224
14.11. Classification and Categories	224
14.12. Selection of Fuse Links	225
14.13. Protection of Motor	227
14.14. Discrimination	228
14.15. Protection of Radial Lines	228
14.16. Protection of Meshed Feeders with Steady Load - by HRC Fuses	230
14.17. Equipment Incorporating Fuses	230
14.18. High Voltage Current Limiting Fuses	231
14.19. Expulsion Type High-voltage Fuse	231
14.20. Drop-out Fuse	231
14.21. Test on Fuse	232
15-A. METAL-ENCLOSED SWITCHGEAR, CONTROLGEAR AND CONTACTOR	233-248
15.1. Introduction	233
15.2. Types of Switchgear	233
Part A : High Voltage Indoor Metal Enclosed Switchgear	
15.3. General Features of Indoor Metal-enclosed Switchgear	234
15.4. Draw-out Type Metal-enclosed Switchgear	235
15.5. Switchgear with Vacuum Interrupters	237
Part B : Low-Voltage Metal Clad Switchgear and Low Voltage Circuit Breakers	
15.6. Unit Type Metal Clad Low Voltage Switchgear and Motor Control Centers	237
15.7. Low Voltage Circuit Breakers	239
15.7.1. Classification.	239
15.7.2. Rated Quantities	239

15.7.3. Test on Low-voltage Circuit-breakers	241
15.8. 'Explosion-proof' or 'Flame-proof' Switchgear	241
Part C : Low Voltage Controlgear and Contractors	
15.9. Low Voltage Control Gear	242
15.10. Contactors	242
15.11. Some Terms and Definitions	242
15.12. Contactor Starters for Motors	243
15.13. Rated Characteristics of Contactors	243
15.14. Tests on Contactors	244
Part D : Control Boards	
15.15. Control Boards or Control Panels	246
15.16. Control Room-layouts	247
15-B. MEDIUM VOLTAGE METAL ENCLOSED SWITCHGEAR WITH SF₆ CB AND VCB	
249-260	
Part I : Applications and Range	
15.17. Type and Range	249
15.18. Iec and Cired Classification	249
Part II : Constructional Aspects	
15.19. Configuration and Variants	250
15.20. Drawings and Diagrams	252
15.21. Designation for the Degree of Protection	252
Part III : Switchgear Phenomena with Medium Voltage Switchgear with SF₆ C.B. with VCB	
15.22. Cable Terminations Systems	254
15.23. General Assessment Criteria	255
15.24. Interruption of Inductive Currents and Small Inductive Currents	256
15.25. Switching-on of a Motor, Voltage Surge Due To Multiple Reignition	257
15.26. Motor Switching with Puffer Type SF ₆ Circuit-breakers	258
15.27. Capacitor Switching	259
15-C. LOW-VOLTAGE CONTROLGEAR AND SWITCHGEAR	
261-272	
15.28. Applications and Basic Requirements	261
15.29. Components and Modular Structural Configuration	261
15.30. Switching Devices	262
15.31. Mechanical Rated Life of a Switching Device	263
15.32. Design Aspects for Long Mechanical Life	264
15.33. Main Electrical Circuit and Components in A Switching Device	265
15.34. Main Circuit Components Associated with Contactor Starters of LV	265
15.35. Protection Aspects	266
15.36. Contact Travel Characteristics of LV Switching Device During Operating and Closing Operations, Switching Time Definitions.	266
15.37. Connection and Cross Sectional Area of Cables	267
15.38. Contact Configuration and Design Aspects	268
15.39. Contact Materials	268
15.40. Contact Speed During Opening Operation	268
15.41. Auxiliary Switches	269
15.42. Tripping Device and Relays	269
15.43. Degree of Protection, IP Code	270
15.44. Medium Voltage Vacuum Contactors for 3.6 to 12 KV	271

16. HVDC CIRCUIT-BREAKER AND METALLIC RETURN TRANSFER BREAKER (MRTB)	
273-290	
16.1. Introduction to HVDC Switching System	273
16.2. Schematic of a 2-terminal, Bipolar Long Distance Hvdc, Trans-Mission System	276
16.3. Back-to-back HVDC System	278
16.4. Multi-terminal HVDC Systems (MTDC)	280
16.5. Schematic of DC Switching System and Waveform of IDC with Artificial Current Zeros	281
16.6. Conclusion	281
16.7. Energy Consideration in Breaking Direct Current In Hvdc Circuit-Breakers	282
16.8. Hvdc Switching System	284
16.8.1. Commutation Principle of Hvdc Circuit-breaker	284
16.9. Control of dI/dt and dv/dt	285
16.10. Triggered Vacuum Gaps (TVG)	286
16.11. Surge Suppression	286
16.12. Complete Circuit of HVDC Switching System	286
16.13. Main Circuit-breaker for Hvdc Switching	286
16.14. Switching Devices in Present Bipolar HVDC Substations	287
16.15. Types of HVDC Circuit-breakers	287
16.16. Hvdc Circuit-breaker Capabilities and Characteristics	289
16.17. Definitions of Switching Time for HVDC Circuit-breakers	289
16.18. Short-circuit Ratio (SCR) of HVDC System	290
16.19. Conclusions	290
17. ELECTRICAL SUBSTATIONS, EQUIPMENT AND BUS-BAR LAYOUTS	
291-339	
17.1. Introduction	291
17.2. Substation Equipment and Outdoor Yard Layout	292
17.3. Isolator and Earthing Switch	295
17.3.1. Requirement and Definitions	295
17.3.2. Types of Construction of Isolators	296
17.3.3. Pantograph Isolator	298
17.3.4. Ratings of Isolators and Tests	298
17.4. Bus-bar Arrangements in Switchyards	299
17.4.1. Bus-bar System Recommended for Large Important Sub-stations	303
17.4.2. Maintenance Zoning	303
17.5. Use a Load Break Switches	303
17.6. Switchgear in Generating Stations	304
17.6.1. Main Switchgear Schemes	304
17.6.2. Unit System of Generator Connections : (Scheme Without Generator-circuit-breaker)	305
17.6.3. Unit Scheme Employing Generator Circuit Breaker	306
17.6.4. Main Switchgear in Generating Stations	306
17.6.5. Single and Multiple Generator Transformer Unit	306
17.7. Auxiliary Switchgear in Power Stations	307
17.8. Isolated Phase Bus Systems	309
17.9. Continuous Housing Type Isolated-phase Buses	310
17.10. Switching Sub-stations	316
17.11. Layout the Switchyard Equipment	316
17.12. Location of Current Transformers	318
17.13. Typical Substation in Distribution System	318

17.14. Switchgear for a Medium Size Industrial Works	318
17.15. Bus-bars	319
17.16. Some Terms and Definitions	320
17.17. Materials for Bus-bars	320
17.18. Bus-bar Design	322
17.19. Electrodynamic Forces on Bus-bars During Short-circuits	322
17.20. Important Techno-economic Consideration for Construction of Sub-stations/switchyards	327
17.20.1. Activities in Construction of Sub-station	330
17.20.2. Cost Effectiveness	330
17.20.3. Ways and Means of Economizing	331
17.20.4. Construction Activities	331
17.20.5. Maintenance of Over-head Transmission Lines	334
17.20.6. Maintenance and Repair	334
18-A. TRANSIENT OVERVOLTAGE SURGES, SURGE ARRESTERS AND INSULATION CO-ORDINATION	340-359
18.1. Introduction	340
18.2. Terms and Definitions	346
18.3. Choice of Insulation Levels of Sub-station Equipment	348
18.4. Protective Ratio, Protective Margin	349
18.5. Lightning	349
18.6. Overhead Shielding Screen (Earthed)	350
18.7. Lightning Stroke on OH Lines (Overhead Line)	351
18.8. Protective Devices Against Lightning Surges	351
18.9. Rod Gaps or Spark Gap	352
18.10. Surge Arresters (Lightning Arresters)	352
18.11. Surge Arrester Specifications and Terms	355
18.12. Tests on Surge Arresters	356
18.13. Rated Voltage of Surge Arrester	356
18.14. Coefficient of Earthing (C_e) is the Ratio :	357
18-B. NEUTRAL GROUNDING (NEUTRAL EARTHING)	360-373
18.15. Introduction to Neutral Grounding	360
18.16. Terms and Definitions	360
18.17. Disadvantages of Ungrounded Systems	360
18.18. Advantages of Neutral Grounding	362
18.19. Types of Grounding	364
18.20. Reactance in Neutral Connection	365
18.21. Connection of the ARC Suppression Coil	367
18.22. Neutral Point Earthing of Transformer L.V. Circuits.	368
18.23. Neutral Grounding Practice	369
18.24. Earthing Transformer	370
18.25. Ratings of Neutral Devices	371
18-C. SUBSTATION EARTHING SYSTEM AND EQUIPMENT EARTHING	374-388
18.26. Equipment Earthing (Grounding)	374
18.27. Functions of Substation Earthing System	375
18.28. Connection of Electrical Equipment to Station-earthing System	376
18.29. Substation Earthing System	377

18.30. Earth Electrodes	378
18.31. Integrated Earthing Systems for Two or More Installations	381
18.32. Step Potential and Touch Potential	381
18.33. Earth-resistance of Earthing System	382
18.34. Earth Resistance Measurement	383
18.35. Earthed Screens	385
SECTION II - FAULT CALCULATIONS	
19. INTRODUCTION TO FAULT CALCULATIONS	389-402
19.1. Introduction	389
19.2. Procedure of Fault Calculations	390
19.3. Representation of Power Systems	391
19.4. Per Unit Method	391
19.5. Advantages of Per Unit System	392
19.6. Selection of Bases	392
19.7. Single Phase Circuits : Determinations of Base-impedance (or Resistance or Reactance)	393
19.8. Change of Base	393
19.9. Circuits Connected by Transformer	394
19.10. Reactances of Circuit Elements	395
19.11. Induction Motors	395
19.12. Synchronous Motor	395
19.13. Thevenin's Theorem	396
19.14. Some Terms	399
19.15. Star-delta Transformation	400
20. SYMMETRICAL FAULTS AND CURRENT LIMITING REACTORS	403-437
20.1. Fault Mva and Fault Current (Steady State)	403
20.2. Solved Examples	403
20.3. Procedure Recommended by Standards for Short-circuit Calculations in Distribution Systems.	414
20.4. Reactors in Power Systems	418
20.5. Principle of Current Limiting Reactors	418
20.6. Design Features of Current Limiting Reactors	419
20.7. Dry, Air Cored Series Reactor	420
20.8. Oil Immersed Non-magnetically Shielded Reactor	420
20.9. Oil Immersed Shielded Reactors	420
20.10. Terms and Definitions	420
20.11. Physical Arrangement of Series Reactors	421
20.12. Selection of Reactors	421
20.13. Location of Series Reactors	422
20.14. Effective Short Circuit Level (ESCL) by Considering Kvar Contribution of Shunt Capacitor Banks	422
20.15. Effective Short Circuit Ratio (ESCR)	432
21. SYMMETRICAL COMPONENTS	438-447
21.1. Introduction	438
21.2. Symmetrical Components of 3-phase Systems	438
21.3. Operator 'a'	439
21.4. Some Trigonometric Relations	440

21.5. Zero Sequence Currents	442
21.6. Phase Displacement in Star-delta Transformers	446
22. UNSYMMETRICAL FAULTS ON AN UNLOADED GENERATOR	448-462
22.1. Sequence Impedances	448
22.2. Sequence Networks of Alternator	448
22.3. Voltage Equations	448
22.4. Single Line to Ground Fault on an Unloaded Three-phase Alternator at Rated Terminal Voltage	449
22.5. Double Line to Ground Fault on an Unloaded Generator	450
22.6. Line to Line Fault on Unloaded Alternator (Generator)	452
23. FAULTS ON POWER SYSTEMS	463-475
23.1. Sequence Networks	463
24. USE OF A.C. NETWORK ANALYSER AND DIGITAL COMPUTER IN FAULT CALCULATIONS	476-484
24.1. Introduction	476
24.2. A.c. Network Analyzer (A.C. Calculating Board)	476
24.3. Digital Computers	478
24.4. Organization of a Digital Computers	478
24.5. Process of Solving Engineering Problems on Digital Computers	478
24.6. (i) Short Circuit Studies on Digital Computer	479
SECTION III — POWER SYSTEM PROTECTION	
25. INTRODUCTION TO PROTECTIVE RELAYING	485-499
25.1. About Protective Relaying	485
25.2. Faults, Causes and Effects	486
25.3. Importance of Protective Relaying	487
25.4. Protective Zones	487
25.5. Primary and Back-up Protection	488
25.6. Back Up Protection by Time Grading Principle	489
25.6.1. Back-up Protection by Duplication Principle	490
25.6.2. Monitoring	490
25.7. Desirable Qualities of Protective Relaying	490
25.7.1. Selectivity and Discrimination	490
25.7.2. Relay Time and Fault Clearing Time	490
25.7.3. Sensitivity	491
25.7.4. Stability	492
25.7.5. Reliability	493
25.7.6. Adequateness	493
25.8. Some Terms in Protective Relaying	494
25.9. Distinction Between Relay Unit, Protective Scheme and Protective System	494
25.10. Protective Current Transformers and Voltage Transformers	496
25.11. Actuating Quantities	496
25.12. Electro-mechanical Relays and Static Relays	497
25.13. Power Line Carrier Channel (PLC)	497
25.14. Programmable Relay	497
25.15. System Security	498
25.16. Role of Engineers	498

26. ELECTROMAGNETIC RELAYS	500-519
26.1. Introduction	500
26.2. Basic Connections of Trip Circuit	500
26.3. Auxiliary Switch, Sealing, and Auxiliary Relays	501
26.3.1. Auxiliary Switch	501
26.3.2. 'sealing', 'holding', 'repeat Operation'	501
26.4. Measurement in Relays	502
26.4.1. Magnitude Measurement	503
26.4.2. Product Measurement	503
26.4.3. Ratio Measurement	503
26.4.4. Vector Difference (or Vector Sum)	503
26.5. Type of Relays Units	503
26.6. Pick-up	503
26.7. Reset or Drop-off	504
26.8. Drop Off/pick-up Ratio	504
26.9. Attracted Armature Relay (Electromagnetic Attraction)	504
26.10. Balanced Beam Relay (Electromagnetic Attraction Principle)	506
26.11. Induction Disc Relay (Electromagnetic)	507
26.11.1. Plug Setting and Time Setting in Induction Disc Relays	510
26.11.2. Effect of Time-setting	510
26.12. Induction Cup Relay (Electromagnetic)	510
26.13. Permanent Magnet Moving Coil Relay	511
26.14. Rectifier Relay Systems	512
26.14.1. Relays for One Quantity	512
26.14.2. Relays for Two Quantities	513
26.15. Thermal Relays, Bimetal Relays, Thermocouples	513
26.16. Directional Relays	514
26.16.1. Principle of Measurements	514
26.16.2. Directional Relays	514
26.16.3. Principle of Operation of Directional Element	515
26.17. Polarized Moving Iron Relays	516
26.18. Frequency Relays	516
26.19. Under-voltage Relays	517
26.20. D.C. Relays	517
26.21. All-or-nothing Relays	517
26.22. Plug Setting	518
26.23. Time Setting	518
26.24. Test Facility	518
27. OVERCURRENT PROTECTION AND EARTH FAULT PROTECTION	520-530
27.1. Introduction	520
27.2. Applications of Over-current Protection	521
27.3. Relays Used in Over-current Protection	521
27.4. Characteristics of Relay Units for Over-current Protection	521
27.4.1. Connection Scheme with Three Over-current Relays	522
27.5. Earth-fault Protection	523
27.6. Connections of Ct's for Earth-fault Protection	523
27.6.1. Residually Connected Earth-fault Relay	523
27.6.2. Earth-fault Relay Connected in Neutral to Earth Circuit	524
27.7. Combined Earth-fault and Phase-fault Protection	525
27.8. Earth-fault Protection with Core Balance Current Transformers. (Zero Sequence CT)	525

27.9. Frame-leakage Protection	527
27.10. Directional Over-current Protection	528
27.11. Directional Earth-fault Protection	529
28. DIFFERENTIAL PROTECTION	531-535
28.1. Differential Protection	531
28.2. Applications of Differential Protection	531
28.3. Principle of Circulating Current Differential (merz-prize) Protection	531
28.4. Difficulties in Differential Protection	531
28.5. Differential Protection of 3-phase Circuits	532
28.6. Biased or Per Cent Differential Relay	533
28.7. Settings of Differential Relays	533
28.8. Balanced Voltage Differential Protection	534
29. DISTANCE PROTECTION	536-549
29.1. Introduction to Distance Protection	536
29.2. Principle of R-X Diagram	536
29.3. Theory of Impedance Measurement	536
29.3.1. R-X Diagrams of Plain Impedance Relay	537
29.3.2. Plain Impedance Characteristics	538
29.3.3. Disadvantages of Plain Impedance Relay	539
29.3.4. Time Characteristic of High Speed Impedance Relay	539
29.4. Methods of Analysis	540
29.5. Directional Impedance Relay	540
29.6. Torque Equation of Directional Impedance Relay	540
29.7. Modified (Shifted) Characteristic	541
29.8. Reactance Type Distance Relay	542
29.9. Mho Type Distance Relay	542
29.10. Application of Distance Protection	543
29.10.1. R-X Diagram	544
29.10.2. Line Characteristics	544
29.10.3. Condition for Relay Operation	544
29.10.4. Operating Time	545
29.10.5. Stages of Relay Time Characteristics	545
29.10.6. Co-ordinated Characteristics of Distance Relays in Three Stations.	545
29.10.7. Significance of R-X Diagram and Method of Analysis	546
29.10.8. Load Impedance	547
29.10.9. Line Impedance	547
29.10.10. Power Swings	547
29.10.11. Choice of Characteristic Mho/reactance Mho/static	548
30. PROTECTION OF TRANSMISSION LINES	550
30.1. Introduction	550
Part A : Overcurrent Protection of Transmission Lines	550
30.2. Non-directional Time Graded System of Feeder (or Line) Protection	551
30.3. Directional Time and Current-graded System	553
30.4. Setting of Directional Over-current Relays of a Ring Main	554
30.5. Current Graded Systems	554
30.6. Definite Time Overcurrent Protection of Lines	556
30.7. Earth Fault Protection of Lines	556
30.8. Summary of Overcurrent Protection of Lines	557

Part B : Distance Protection of Transmission Lines	
30.9. Introduction to Distance Protection of H.V. and E.H.V. Lines	557
30.9.1. Plain Impedance Protection	559
30.9.2. Directional Impedance Relay	559
30.9.3. Reactance Relay	560
30.9.4. Mho Relay Admittance Relays	560
30.9.5. Offset Mho Characteristic	561
30.10. Distance Schemes	561
30.11. Starting Element (Fault Detectors)	562
30.12. Stepped Characteristic	563
30.13. Three Step Distance-time Characteristic	564
30.14. Power Swings	564
30.15. Carrier Assisted Distance Protection	565
30.15.1. Carrier Transfer (Intertripping)	565
30.15.2. Carrier Blocking Scheme (Directional Comparison Method)	566
30.15.3. Carrier Acceleration	567
30.16. Distance Schemes for Single Pole and Triple-pole Auto-Reclosing	567
30.17. Connections of Distance Relays	567
Part C : Protection of Based on Unit Principle Lines	
30.18. Pilot Wire Protection Using Circulating Current Differential Relying	568
Part D : Carrier Current Protection of Transmission Lines	
30.19. Carrier Current Protection	571
30.20. Phase Comparison Carrier Current Protection	574
30.21. Applications of Carrier Current Relying	577
30.22. Radio Links or Microwave Links	577
31. PROTECTION OF INDUCTION MOTORS	579-592
31.1. Introduction	579
31.2. Abnormal Operating Conditions and Causes of Failures in Induction Motors	580
31.3. Protection Requirements	581
31.4. Protection of Low Voltage Induction Motor. (below 1000V AC)	581
31.4.1. Scheme of Starting Circuit	581
31.4.2. Bimetal Overload Devices	582
31.4.3. Short Circuit Protection by Hrc Fuses	583
31.5. Protection of Large Motors	584
31.6. Overload Protection of Induction Motors	584
31.7. Protection Against Unbalance	586
31.8. Protection Against Single-phasing (Phase Failure)	587
31.9. Phase Reversal Relay	588
31.10. Phase to Phase Fault Protection	588
31.11. Stator Earth-fault Protection	590
31.12. Faults in Rotor Winding	591
32. PROTECTION OF TRANSFORMERS	593-613
32.1. Protection Requirements	593
32.2. Safety Devices with Power Transformers	595
32.3. Low Oil Level—Fluid Level Gauge	595
32.4. Gas Actuated Devices	595
32.4.1. Pressure Relief and Pressure Relay	595
32.4.2. Rate-of-rise Pressure Relay	596

32.4.3. Buchholz Relay (Gas Actuated Relay)	596
32.5. Biased Differential Protection, Percentage Differential Protection of Power Transformer	598
32.6. Problems Arising in Differential Protection Applied to Transformers	603
32.7. Harmonic Restraint and Harmonic Blocking	604
32.8. Differential Protection of Three-winding Transformer	604
32.9. Differential Protection of Auto-transformers	605
32.10. Earth-fault Protection	606
32.11. Restricted Earth Fault Protection	606
32.12. Protection of Transformers in Parallel	608
32.13. Overcurrent Protection of Power Transformers	608
32.13.1. Overload Protection	609
32.14. Thermal Over-heating Protection of Large Transformers	610
32.15. Over-fluxing Protection	610
32.16. Protection of Arc Furnace Transformers	611
32.16.1. Power Supply Requirements of Arc Furnace Plants	611
32.17. Protection of Rectifier Transformer	612
32.18. Protection of Grounding Transformer	612
33. PROTECTION OF GENERATORS	614-643
33.1. Introduction	614
33.2. Abnormal Conditions and Protection Systems	616
33.2.1. External Faults.	616
33.2.2. Thermal Overloading.	616
33.2.3. Unbalanced Loading.	617
33.2.4. Stator Winding Faults.	617
33.2.5. Field Winding Faults.	618
33.2.6. Overvoltages	618
33.2.7. Other Abnormal Conditions.	619
33.3. Percentage Differential Protection of Alternator Stator Windings	621
33.4. Restricted Earth-fault Protection by Differential System	623
33.5. Overcurrent and Earth-fault Protection for Generator Back-up	627
33.6. (a) Sensitive Stator Earth-fault Protection	628
33.7. Protection Against Turn-to-turn Fault on Stator Winding	629
33.8. Rotor Earth Fault Protection	631
33.9. Rotor Temperature Alarm	632
33.10. Negative Sequence Protection of Generators Against Unbalanced Loads	632
33.11. Negative Phase Sequence Circuit	633
33.12. Stator-heating Protection	635
33.13. Loss of Field Protection	635
33.14. Reverse Power Protection	635
33.15. Over-speed Protection	636
33.16. Field Suppression	637
33.17. Other Protections	637
33.18. Protection of Small, Standby Generators	638
33.19. Generator Transformer Unit Protection	639
33.19.1. Combined Differential Protection for Generator Main Transformer	639
33.20. Static Protection of Large Turbogenerators And Main Transformer	639
33.21. Static, Digital, Programmable Protection System For Generator and Generator-transformer Unit	641

34. STATION BUS-ZONE PROTECTION	644-655
34.1. Introduction	644
34.2. Bus Protection by Overcurrent Relays of Connected Circuits	645
34.3. Bus Protection by Distance Protection of Incoming Line as a Remote Back-up	646
34.4. Bus-zone Protection by Directional Interlock	646
34.5. Bus-zone Protection by Differential Principle	647
34.6. Problems in Bus-zone Differential Protection	648
34.7. Selection of CTS for Bus-zone Protection	649
34.8. Biased Differential Bus-zone Protection	650
34.9. High Impedance Circulating Current Differential Bus-zone Protection	650
34.10. High Impedance Differential Protection Based on Voltage Drop	650
34.11. High Impedance-voltage Differential System	651
34.12. Check Features in Bus Protection	652
34.13. Location of CT's	652
34.14. Monitoring of Secondary Circuits	652
34.15. Interlocked Overcurrent Protection for Buszone and Generator-unit Zone	653
34.16. Non-auto Reclosure and Simultaneous Three-pole Operation	654
34.17. Bus Transfer Schemes for Auxiliary Switchgear and Industrial Switchgear	654
35. CURRENT TRANSFORMERS AND THEIR APPLICATIONS	656-675
35.1. Introduction	656
35.2. Terms and Definitions	657
35.3. Accuracy Class	658
35.4. Burden on CT	659
35.5. Vector Diagram of CT	661
35.6. Magnetisation Curve of CT	663
35.7. Open Circuited Secondary of CT	664
35.8. Polarity of CT and Connections	664
35.9. Selection of Current Transformers of Protection Ratings	665
35.10. CT's for Circulating Current Differential Protection	666
35.11. CT's for Other Protection Systems ; CT's for Distance Protection	668
35.12. Type of Construction CT's	668
35.13. Core Shapes for Multiturn Wound Primary Type CT	669
35.14. Current Transformer for High Voltage Installations	670
35.15. Intermediate CT	670
35.16. Testing of CT's (Brief)	672
35.17. Transient Behaviour of CT's	673
36. VOLTAGE TRANSFORMERS AND THEIR APPLICATIONS	676-689
36.1. Introduction	676
36.2. Theory of Voltage Transformers	676
36.3. Specifications for Voltage Transformers	678
36.4. Terms and Definitions	678
36.5. Accuracy Classes and Uses [B.S. 3914 (1965)]	679
36.6. Burdens on Voltage Transformer	679
36.7. Connections of VT's	680
36.8. Residually Connected VT (Zero Sequence Voltage Filter)	682
36.9. Electromagnetic Voltage Transformer	682
36.10. Capacitor Voltage Transformers (CVT)	683
36.10.1. CVT with Stepped Output	684

36.10.2. Protection of Voltage Transformers	684
36.11. CVT as Coupling Capacitor for Carrier Current Applications	684
36.12. Choice of Capacitance Values for CVT	684
36.13. Transient of Behaviour of CVT	686
36.14. Ferro-resonance (FR) in CVT	686
36.15. Testing of Voltage Transformer (BRIEF)	687
36.16. Application of Capacitor Type Voltage Transformer for Protective Relaying	687
37. TESTING AND MAINTENANCE OF PROTECTIVE RELAYS	690-702
37.1. Importance of Maintenance and Setting	690
37.2. Tests on Relays	690
37.3. Test Equipment	691
37.4. Routine Maintenance Tests	692
37.5. Inspection and Testing for Acceptance	693
37.6. Some Tests on CT's	694
37.7. Some Tests on PT's	694
37.8. Some Test Circuits and Procedures for Secondary Injection Tests	695
37.9. Manufacturer's Tests	698
37.10. Commissioning Tests	699
SECTION IV — STATIC RELAYS AND STATIC PROTECTION SCHEMES	
38-A. INTRODUCTION TO STATIC AND MICROPROCESSOR-BASED INTEGRATED PROGRAMMABLE PROTECTION, MONITORING AND CONTROL SYSTEMS	703-720
38.1. Introduction and Definition	703
38.2. Static Versus Electromagnetic Relays	706
38.3. Limitations of Static Relays	708
38.4. Reliability and Security of Static Relays	709
38.5. Historical Review in Brief	710
38.6. Recent Development of Static Relays	710
38.7. Present Trends in Protection and Control Technology	711
38.8. Modular Concept, Building-block Principle Used in Predominantly Static Protection Systems	714
38.9. Static Relay Functional Circuits and Index of Functions	714
38.10. Types of Measuring and All-or-nothing Relay Units	715
38.11. Analogue and Digital Sub-systems in Protective Relaying	716
38.12. Analogue Protection Systems	716
38.13. Limitations of Analogue Systems	718
38.14. Digital and Programmable Electronic Static Relays	718
38.15. Hardwire Digital Systems	718
38.16. Programmable Digital Protective and Control Systems	719
38.17. Forms of Digital Electronic Circuits	719
38.18. Integration a Control and Protection for High Voltage AC Substation	719
38-B. INTRODUCTION TO ANALOGUE AND DIGITAL STATIC RELAYS	721-752
Section I : Solid State Devices	
38.19. Semiconducting Materials	721
38.20. Solid-state Devices : (Brief Introduction)	722
38.20.1. Semiconductor Diode	722
38.20.2. Zener-Diodes (Voltage Regulating Diodes)	723

38.20.3. Pnnp Devices and Thyristor Tripping Circuit	725
38.20.4. Power Switching Techniques with "Thyristors"	726
38.20.5. Triac	726
38.20.6. Thermistors	726
38.20.7. Resistors	726
38.20.8. Capacitors	727
38.21. Printed Circuit Boards with Discrete Components	727
38.22. Static Relays with Integrated Circuits	727
38.22.1. Reed Relays	728
38.23. Static Directional Units	729
Section II : Digital Circuits and their Applications in Protective Relaying	
38.24. Logic Circuits	730
38.25. And Function	731
38.26. Or Function	733
38.27. Not Function	734
38.28. Combined Functions	734
38.29. Memory Function (Storage Function)	735
38.30. Families of Logic Circuits	736
38.31. Applications of Logic Circuits in Protective Relaying	738
38.32. Definition and Application	738
38.33. Symbol of Operational Amplifier	739
38.34. Characteristics of Ideal Operational Amplifier	739
38.35. Some Applications of Operational Amplifiers	740
38.35.1. Analogue Level Detector or Comparator	742
38.35.2. Analogue/digital Conversion	743
38.35.3. Digital to Analogue Conversion	745
38.35.4. Digital Multiplexers	745
38.35.5. Encoders and Decoders	745
38.35.6. Programmable System	745
38.35.7. Microprocessor	746
38.35.8. Microprocessor Module	746
38.35.9. Hybrid of Analogue and Digital Systems	746
38.36. Auxiliary Voltage Supply for Static Relays	746
38.37. Full-wave Rectifier	747
38.38. Smoothing Circuits	747
38.39. Voltage Stabilization (Regulation) by Zener Diodes	748
38.40. Time-delay Circuits	748
38.41. Frequency Filters	749
38.42. Symmetrical Component Filters	750
39. COMPARATORS AND LEVEL DETECTORS	753-765
39.1. Static Relay Functional Circuits	753
39.2. Comparators	754
39.3. Amplitude Comparators	755
39.4. Phase Comparators	756
39.5. Phase Comparator Based on Rectangular (or Squared) Pulses	756
39.6. Phase Comparators Based on Vector Product Devices	757
39.7. Direct (Instantaneous) and Integrating Type Comparators	758
39.8. Integrating Amplitude Comparator	758
39.9. Operating Time	759
39.10. Coincidence Techniques in Phase Comparators	759

39.11. Spikes and Block Coincidence Technique in Phase Comparator	760
39.12. Phase Comparator with Phase Splitting Technique	761
39.13. Hybrid Comparator	761
39.14. Level Detector	762
39.15. Level Detector by pnp Transistor	762
39.16. Npn Transistor as Level Detector	763
39.17. Schmitt Trigger with Operational Amplifier	763
39.18. Schmitt Trigger with Two NPN Transistor	764
40. STATIC OVERCURRENT RELAYS	766-778
40.1. Introduction to Static Overcurrent Relays	766
40.2. Single Actuating Quantity Relays	766
40.3. Double Actuating Quantity Relays	767
40.4. Basic Principle of Static Overcurrent Relays	768
40.5. Time Characteristic	769
40.6. Timing Circuit	770
40.7. Directional Overcurrent Relay	771
40.8. Static Instantaneous A.C. Measuring Relays	773
40.9. Static Time-lag Over-current Relays	774
40.10. Static Directional Relay	776
41. STATIC DIFFERENTIAL PROTECTION OF POWER TRANSFORMERS	779-784
41.1. Introduction	779
41.2. Differential Protection of Two-winding Transformer	780
41.3. Differential Protection of Three Winding Transformer	781
41.4. Inrush-proof Qualities.	782
41.5. Requirements to be Fulfilled by the Main CT	783
41.6. Auxiliary C.T.	783
42. STATIC DISTANCE RELAYS AND DISTANCE PROTECTION OF EHV LINES	785-802
42.1. Introduction	785
42.2. Voltage Comparator and Current Comparator	786
42.3. Three-input Amplitude Comparator	790
42.4. Hybrid Comparator	791
42.5. Four Input Phase Comparator with Quadrangular Characteristic	792
42.6. Errors in Distance Measurement	792
42.7. Influence of Power Swings on Distance Protection	793
42.7.1. Power Swings	793
42.7.2. Effect of Power Swing on the Starting Elements in Distance Schemes.	793
42.7.3. Effect of Power Swing on the Measuring Elements in Distance Schemes.	794
42.7.4. Representation of Power Swing on R-X Diagram	794
42.8. Protection of Teed Lines by Distance Relays	796
42.9. Back-up Protection with Intermediate Infeed	796
42.10. Compensation or Compounding in Distance Relays	797
42.11. Setting of Distance Relays	798
42.12. Solved Examples on Distance Relay Setting	798
43-A. IMPORTANT ASSORTED TOPICS AND STATIC PROTECTION SCHEMES	803-827
43.1. Combating Electrical Noise and Interferences	803
43.2. Transient Overvoltages in Static Relays	804

43.3. Protection of Static Relay Circuit	806
43.4. Recommended Protection Practices for Static Relaying Equipment	807
43.5. Testing of Static Relays with Regard to Over-voltage Transients	808
43.6. Reliability, Dependability, Security	809
43.7. Static Relay for Motor Protection	811
43.8. Static Busbar Protection Based on Directional Comparison	814
43.9. Disconnection of Mains Supply From Inplant Auxiliary Supply During System Faults	816
43.10. Breaker Back-up Local Back-up	817
43.11. Use of Micro Processor for Local Back-up	818
43.12. Computer Based Centrally Coordinated Back-up	820
43.13. Programmable Equipment for Protective Relaying Measurements and Control (PPRMC)	820
43.14. Principle of Centralized Back-up Protection (CBP)	821
43.15. Post-faulty Control (PFC) by Digital Computers	822
43.16. Communication Links for Protection Signalling	823
43.17. Fibre Optic Data Transmission	823
43.18. Local Breaker Back-up Protection : Breaker Fail Protection ; Stuck-breaker Protection	824
43.19. Uninterrupted Power Supply (UPS)	825
43.20. Directional Wave Relays for Fault Detection And Protection of Overhead Lines	826
43-B. DIGITAL RELAYS, MICROPROCESSORS BASED RELAYS, FAULT RECORDERS AND FAULT LOCATORS	828-854
43.21. Enter Microprocessors in Protection Technology	828
43.22. Block Diagram and Components of a Digital Relay	829
43.23. Basic Principles of Digital Relays	831
43.24. Microprocessor Based Relays	834
43.25. Description of a Microprocessor Based Protective Relay for Motor Protection	834
43.26. Advantages of and Special Features of Microprocessor Based Protective Relays	837
43.27. Block Diagram of a Microprocessor Based Distance Relay for Protection of Transmission Line	838
43.28. Architecture of a Microprocessor	841
43.29. Programming of Microprocessors Based Relays	847
43.30. Self-checking And/or Self Monitoring in Microprocessor based Relay	847
43.31. On Line Microprocessor Based Fault Monitoring	849
43.32. Microprocessor Based Fault Locators	849
43.33. Principle of Fault Detection in on Line Digital Relays, Fault Locators and Fault Recorders	851
43-C. MODERN PROTECTION SYSTEM	855-864
43.34. Introduction	856
43.35. Numerical Relays	856
43.36. Traditionally Separate Networks	857
43.37. Ethernet just a Physical Layer Standard	858
43.38. The IEC's Initiative	859
43-D. MICROPROCESSOR BASED SUBSTATION PROTECTION CONTROL AND MONITORING	865-871
43.39. Introduction	865
43.40. Equipment to Automatic Control Substations	865

43.41. Two Subsystems in Substations	866
43.42. Two Hierarchical Levels in a Substation	866
43.43. Substation Level (Upper Level)	867
43.43.1. Unit Level	868
43.43.2. Inter-level Communication	869
43.44. Functions Performed by Protection and Control Equipment	870
43.45. Protection and Control Configuration	871
SECTION V — POWER SYSTEM ANALYSIS, INTERCONNECTION AND POWER SYSTEM CONTROL SCADA SYSTEMS	
44. POWER SYSTEM STABILITY, AUTO-RECLOSING SCHEMES, METHODS OF ANALYSIS AND IMPROVEMENT OF TRANSIENT STABILITY	875-919
Part A : Concept of Power System	
44.1. Power System Stability	875
44.2. Concept of Power System Stability	877
44.3. Single Machine Against Infinite Bus	880
Part B : Swing Curves and Swing Equation, Equal Area Criterion	
44.4. Dynamics of Synchronous Machines, Kinetic Energy, Inertia Constant and Stored Energy	884
44.4.1. Kinetic Energy of a Rotating Mass	884
44.4.2. Inertia Constant H	885
44.4.3. Stored Energy in Rotor of a Syn. Machine	886
44.5. Swing Curve	888
44.6. Derivation of Swing Equation From Fundamentals	889
44.7. Equal Area Criterion of Transient Stability	891
44.8. Critical Clearing Angle	894
44.9. Method of Improving Transient Stability Limit	897
Part C : High Speed Protection and Circuit Breakers	
44.10. High Speed Circuit Breakers and Fast Protective Relaying for Improved Transient Stability	898
44.11. Auto-reclosure Improves Transient Stability	900
44.12. Single Pole Reclosing of Circuit-breakers	901
44.13. Independent Pole Mechanism	902
44.14. Single Pole Tripping	902
44.15. Selective Pole Tripping	902
44.16. Segregated Phase Comparison Relaying (SPCR)	902
44.17. Influence of Power Swings on Transmission Line Protection	903
Part D : Autoreclosing	
44.18. Autoreclosing Schemes	904
44.19. Terms and Definitions Regarding Autoreclosing	904
44.20. Rapid Autoreclosing Scheme	905
44.21. Delayed Autoreclosing Scheme	907
44.22. Synchronism Check	907
44.23. Control Schemes for Auto-reclosing	908
Part E : Modern Definitions of Power System Disturbance, Stability	
44.24. Terms and Definitions in Power System Stability Studies (1980)	909
44.25. Operational Limits with Reference to Steady State Stability Limit and Transient Stability Limit	912
44.26. Methods of Improving Transient Stability Limit	914

45-A. LOAD-FREQUENCY CONTROL, LOAD SHEDDING AND STATIC FREQUENCY RELAY	920-930
45.1. Introduction to System Frequency Control	920
45.2. Load-frequency Characteristics of Rotating Machines	921
45.3. Primary Load-frequency Control	921
45.4. Secondary Load Frequency Control	921
45.5. Load-frequency Control of a Grid	922
45.6. Load Shedding	923
45.7. Use of Frequency Relays for Load Shedding	923
45.8. Static Frequency Relay	924
45.8.1. Turbine Frequency Capability and Under-frequency Limits	925
45.9. Network Islanding	927
45.10. Other Application of Frequency Relay	927
45.11. Load Dispatching and Network Controller	927
45-B. VOLTAGE CONTROL AND COMPENSATION OF REACTIVE POWER	931-958
45.12. Voltage Control in Network (Power System)	931
45.13. Permissible Voltage Variation	932
45.14. Methods of Voltage Control	933
45.15. Compensation of Reactive Power	937
45.16. Effect of Reactive Power Flow on Voltage at Sending-end and Receiving end of Transmission Line	938
45.17. Series Capacitors	938
45.18. Applications of Power Capacitors in Electric Power Systems	940
45.19. Installation of Shunt Capacitors	947
45.20. Reactive Power Requirements and Voltage Regulation Of Ehv/uhv A.C. Lines. Surge Impedance Loading	949
45.21. Reactive Power Management	952
45-C. VOLTAGE STABILITY OF ELECTRICAL NETWORK	959-966
45.22. Introduction to Voltage Stability Studies	959
45.23. Explaining Voltage Instability	959
45.24. Increasing Voltage Stability Limit by Supply of Reactive Power	960
45.25. Sequence of Switching-on and Switching-off Shunt Capacitor Banks	961
45.26. Q—V Characteristics	962
45.27. Voltage Collapse Occurrences, and Their Time-spans	963
45.28. Preventive Measures Against Voltage Collapse	965
45.29. Definitions	965
45-D. AUTOMATIC VOLTAGE REGULATORS, VOLTAGE CONTROL AND STABILITY OF SYNCHRONOUS GENERATORS	967-991
45.30. Introduction	967
45.31. Operation of Synchronous Generator	971
45.32. EMF and No Load Terminal Voltage, Saturation Curve and Air Line	973
45.33. Terminal Voltage of an Isolated Generator with Constant Field Current and Without AVR	974
45.34. Types of Excitation Systems and AVRS	975
45.35. Synchronous Generator in Parallel with the Grid (Infinite Bus)	976
45.36. Types of AVR and Excitation Systems	977
45.37. Terms and Definitions on AVR and Excitation Systems	980

45.38. Excitation Systems and AVR (Synchronous Machine Regulators)	982
45.39. Steady State Performance Excitation Systems and AVRS	984
45.40. Transient Performance of AVRS	984
45.41. Excitation System Voltage Response	985
45.42. Generator Capability Curves	985
45.43. Electrical Load Diagram of a Synchronous Generator Operating In Parallel with the Grid (VT Constant)	987
45.44. Control and Protective Circuits of an Excitation System	988
45.45. Voltage-reactive Power Characteristic for Constant Power	989
46.A. DIGITAL COMPUTER AIDED PROTECTION AND AUTOMATION	992-1012
46.1. Introduction to Power System Control and Operation	992
46.2. Terms Related with Computers and Microprocessors	994
46.3. Supervisory Control and Data Acquisition System for Power System Operation and Control	997
46.4. Data Collection Equipment, Data Loggers	999
46.5. Data Transmission Equipment (Telemetry)	1001
46.6. Applications of Power Line Carrier	1003
46.7. Man-machine Interface	1004
46.8. Application of Computers in Network Automation	1004
46.9. Microprocessors	1005
46.10. Micro-processor Based Micro-computer	1007
46.11. Applications of Digital Computer and Micro-processors in Power System Protection.	1008
46.12. Microprocessor Based Inverse Time Overcurrent (IOT) Relay	1009
46.13. Digital Computers for Power System Operation	1009
46.14. On Line Digital Computer for Protection of Line	1010
46.B. ECONOMIC OPERATION OF POWER SYSTEM AND AUTOMATIC ECONOMIC LOAD DISPATCH	1013-1028
46.15. Classical Method of Loading the Units in a Plant	1014
46.16. Economic Load Distribution Within a Generating Station by Modern Method	1015
46.17. Modern Method of Economic Load Distribution Between Various Generating Stations in a Region	1017
46.18. Distribution of Load Between Generating Stations by Taking Into Account the Transmission Losses : Penalty Factor	1020
46.19. Automatic Load Dispatch Incorporating Load Frequency Control and Economic Load Dispatch	1021
46.20. Transmission Loss as a Function of Output Power of Generating Station	1024
46.21. Network Controller in Load Control Centre	1024
47. HVDC TRANSMISSION SYSTEMS	1029-1066
47.1. Introduction Choice of HVDC Transmission	1029
47.2. HVDC Transmission Systems	1029
47.2.1. Applications of HVDC Transmission Systems	1029
47.2.2. Choice of HVDC Transmission System	1030
47.2.3. Types of HVDC Systems and Brief Description	1031
47.2.4. Long Distance, High Power Bipolar HVDC Transmission Systems	1035
47.2.5. Power Rating of Long Bipole HVDC Transmission System	1035
47.2.6. Configuration and Description of a Bipolar Scheme	1035

47.2.7. Economic Comparison of Bipolar HDVC Transmission System with Ehy-ac System	1037
47.2.8. EHV-AC Versus HVDC.	1038
47.2.9. HVDC Cable Transmission.	1039
47.2.10. HVDC System Interconnection	1040
47.2.11. HVDC Coupling System	1041
47.2.12. EHV-AC Versus HVDC Transmission	1042
47.2.13. Limitations of HVDC Transmission	1044
47.2.14. Terms and Definitions Regarding Hvdc	1044
47.3. Control of Hvdc Link	1045
47.3.1. Steady-state UD/ID Characteristic of Converters.	1045
47.3.2. Intersecting Characteristics of Rectifier and Inverter Under Normal Operating Mode	1046
47.3.3. Intersecting Characteristic Under Steady Condition with Current Margin Control	1047
47.3.4. Power Transmission Characteristic with Constant Current Regulation of Rectifier and Constant Extinction Angle Regulation of Inverter.	1047
47.3.5. Reversal of Power Through an HVDC Link ; Necessity of Reversal of Power.	1048
47.3.6. Alternatives of HVDC Control	1050
47.4. Circuit Arrangements	1053
47.5. Thyristor Valves for HVDC Convertor	1054
47.6. Reversal of Power	1056
47.7. Typical Layout of HVDC Conversion of Sub-station	1056
47.8. Over-voltage Surge Protection	1057
47.9. D.C. Surge Arrestors	1057
47.10. Line Protection System	1058
47.11. AC Harmonics	1058
47.12. Harmonic Filters	1058
47.13. HVDC Simulator	1059
47.14. Protection Systems in HVDC Sub-station	1060
47.14.1. Protection of HVDC Transmission System	1060
47.15. Line Insulation	1062
47.16. Maintenance of HVDC Links	1063
47.17. D.C. Breakers and Load Switches	1063
47.18. Control and Protective Equipment	1064
48.A. EHV — AC TRANSMISSION SYSTEMS AND STATIC VAR SOURCES	1067-1088
48.1. General Background of EHV-AC Transmission	1067
48.2. Voltage Levels for Transmission Lines	1068
48.3. Hierarchical Levels of Transmission and Distribution	1068
48.4. Tasks of Transmission Systems	1070
48.5. Functional Requirements of Transmission Systems and Design Aspects	1070
48.6. Configuration of EHV-AC Transmission System and Bipolar Hvdc Transmission System	1071
48.7. Power Transferability of AC Line	1072
48.8. Line Losses	1072
48.9. Conductor Cost	1073
48.10. Transient Stability Limit of AC Line	1074
48.11. Control of Power Flow Through Line	1074
48.12. Short Circuit Levels	1075
48.13. Voltage Control of AC Lines and Compensation of Reactive Power	1075

48.14. Insulation Co-ordination and Surge Arrester Protection	1076
48.15. Line Insulation, Clearance and Creepage Distances	1076
48.16. Right-of-way (ROW)	1077
48.17. Corona	1077
48.18. Towers (Supports)	1078
48.19. Bundle Conductors (Multiple Conductor)	1078
48.20. Switching Phenomena Associated with EHV-AC Line Switching	1080
48.21. Audible Noise (AN)	1080
48.22. Biological Effect of Electric Field and Limiting Value of Electric Field Strength.	1081
48.23. Radio Interference and Television Interference	1081
48.24. Rapid-auto Reclosing and Delayed Auto-reclosing of Circuit Breakers	1082
48.25. Surge Impedance Loading of AC Transmission Lines	1082
48.26. Sub-synchronous Resonance in Series Compensated Ac Lines	1082
48.27. Static Var System (SVS)	1082
48.28. Applications	1084

49. INTERCONNECTED POWER SYSTEMS

49.1. Introduction	1089-1104
49.2. System Configuration and Principle of Interconnection	1089
49.2.1. Individual System (Region or Area).	1090
49.2.2. Total Generation in Interconnected Systems (national Grid)	1090
49.3. Merits of Interconnected Power System	1090
49.4. Limitations of Interconnected Power Systems	1091
49.5. Obligations of Each Interconnected Systems	1092
49.6. Objectives of Automatic Generation Control and Tie-line Power Flow Control	1092
49.7. Overall Objective and Co-relation Between Real Power and Reactive Power Control and Tie-line Power Flow	1093
49.8. Tie-line Power Flow Control in 2-area System	1094
49.9. Tie-line Power Flow in 3-area System	1096
49.10. Alternative Principles of Control and the Tie-line Bias Control	1096
49.11. Equations of Tie-line Power Flow Control Reviewed	1097
49.12. Actions by the Control Room Operators to Change Tie-line Power	1098
49.13. Actions by Control Room Operators for Voltage Control	1100
49.14. Controlling Tie-line Power by Means of Phase Shifting Transformer (Regulating Transformers)	1100
49.15. Phase Shifting Transformer (Regulating Transformer)	1100
49.16. Types of Interchanges in Interconnected System	1101
49.16.1. Control of Power Flow Through Interconnector	1102
49.17. National Grid and Growth of Power System in India	1103
	1103

50. OPERATION AND CONTROL OF INTERCONNECTED POWER SYSTEMS, AGC AND SCADA

50.1. Introduction	1105-1133
50.2. Main Tasks in Power System Operation	1105
50.2.1. Planning of Operations	1105
50.2.2. Operational Tasks	1106
50.2.3. Operating Accounting and Financial Control	1106
50.3. Automatic Generation Control (AGC)	1108
50.4. Supervisory Control and Data Acquisition (SCADA) System	1108
	1109

50.4.1. Division of Tasks Between Various Control Centres	1112
50.4.2. Functions of Scada Systems	1112
50.4.3. Common Features of All Scada Systems	1113
50.4.4. Alarm Functions	1116
50.4.5. Integration of Measurement Control and Protection Functions by SCADA Systems	1116
50.5. Automatic Sub-station Control	1116
50.6. Scada Configurations	1120
50.7. Energy Management Systems (EMS)	1120
50.8. System Operating States	1123
50.8.1. Normal State (Secure State)	1123
50.8.2. Alert State (Insecure State)	1124
50.8.3. Emergency State	1124
50.8.4. Islanding (In Extermis) State	1124
50.8.5. Restoration State	1124
50.9. System Security	1124
50.9.1. Security Control	1125
50.10. State Estimation	1125
50.11. Expert Systems Using Artificial Intelligence For Power System Operation	1126
50.11.1. What is an Expert System?	1126
50.11.2. Components of Expert System	1126
50.11.3. Example of an Expert System's Working	1126
50.11.4. Applications in Power Systems	1127
50.12. Centralised Diagnostic Expert System Using Artificial Intelligence	1128
50.13. Scada Systems for Power System	1130

51. POWER SYSTEM PLANNING

51.1. Scope of Power System Planning and Design	1134
51.2. Significance of System Planning and Design	1134
51.3. Computer Programmes for Planning	1135

52. IMPROVING DYNAMIC STABILITY BY FLEXIBLE AC TRANSMISSION SYSTEM (FACT) AND HVDC SYSTEMS

	1138-1149
52.1. Inter-relationship Between Voltage, Active Power, Reactive Power, Power Angle, Oscillations and Various Types of Stabilities	1138
52.1.1. Review of Concepts of Power System Stability and Basic equations	1138
52.2. Parameters for Dynamic Control	1139
52.3. Fundamental Requirements of AC Transmission System	1140
52.4. Time Ranges of Abnormal Conditions and Disturbances	1140
52.5. Enter Thyristor Control	1140
52.6. First Swing Period and Oscillators Period	1141
52.7. Review of Power System Problems and Methods for Improvement	1141
52.8. Flexible AC Transmission (FACT)	1144
52.9. Damping of Oscillations in AC Networks by Means of HVDC Damping Control	1145
52.10. Stabilisation of Adjacent AC Lines	1146
52.11. Damping of AC Networks Oscillations with Different Conditions of DC Control for Synchronous HVDC Link	1147

53. COMPUTER AIDED POWER SYSTEM STUDIES

53.1. Computer Aided Engineering (CAE) for Power System Studies	1150
53.2. Purpose and Need of System Studies	1150

58.5.5. Switchgear Installations	1235
58.6. High-voltage Switchgear	1236
58.6.1. Definitions and Electrical Characteristics for HV Switchgear Apparatus	1236
58.6.2. Electrical Characteristics	1237
58.7. Disconnectors and Earth Switches	1238
58.7.1. Circuit Breakers Function	1245
58.7.2. Quenching Medium and Operating Principle for Different Insulating & Quenching Medium	1252
58.7.3. Different Types of Operating Mechanisms of HV, CB	1254
58.7.4. Electrical Control of H.V. Circuit Breakers	1254
58.7.5. Instrument Transformers for Switchgear Installations	1255
58.7.6. Current Transformers	1257
58.7.7. Inductive Voltage Transformers	1261
58.7.8. Capacitive Voltage Transformers	1262
58.8. Surge Arresters	1262
58.8.1. Types of Surge Arresters	1262
58.8.2. Application and Selection	1263
58.8.3. Typical Values of Surge Arresters for the Major Voltage Ratings	1263
58.8.4. Circuit Configurations for High- and Medium-voltage Switchgear Installations	1266
59. ELECTRICAL SAFETY	1273-1290
59.1. Introduction	1273
59.2. Requirements for Electrical Safety	1273
59.3. Relevant Indian Standards	1273
59.4. Special Precautions in Design, Installation Maintenance of Electrical Equipment in Hazardous Locations	1273
59.4.1. Elements for Ignition	1273
59.4.2. Classifications of Hazardous Areas & its Sub-groups	1273
59.5. Hazardous Areas Classification-zones/divisions	1273
59.6. Gas/dust/fibre Groups	1273
59.7. Temperature Class	1273
59.8. Weather Protection	1273
59.9. Material of Construction, Design Characteristics and Conformity Type Test Report	1273
59.10. Marking on Ex-protected Design Electrical Equipment	1280
59.11. Maintenance of Ex-protected Equipment	1281
59.12. Duties and Obligations	1283
59.13. Selection of Right Variety of Ex-protected Equipment	1283
59.14. Explosion Protection Techniques	1284
59.15. Lightning Protection of Structures with Explosive or Highly Flammable Contents	1286
59.16. General Principles of Protection	1287
59.17. Types of Lightning Protection System	1287
59.18. Bonding	1288
59.19. Other Considerations	1288
59.20. Group Classification of Inflammable Gas/vapor	1288
Appendix-A : Recent Trends and Advances Towards 21st Century	1291-1313
Appendix-B : Distribution Management System	1314-1332
Bibliography	1333
Index	1335-1338